Prof. Ford, shows the fresh material available for research, and the progress that has been made through new observations on established species in the last six years. A special list is given of literature on X-rays and crystal structure.

Numerous studies on the thermal behaviour of quartz and on its relations to cristobalite and tridymite come within the period covered by this appendix, and the attention of geologists may well be directed to the references given on p. 66. A cross-reference to these would have been useful under the heads of the other forms of crystalline silica. Among the new species we may note barbierite, which indicates that a monoclinic structure may be formed under certain conditions by the well known felspathic molecule, $NaAlSi_3O_8$. Bazzite, a blue scandium silicate from Baveno, and several vanadium minerals seem attractive novelties. Sefstromite, among the latter, passes away as a mixture. Metallic tantalum, first described in 1909, forms an important record, and specimens have already found their way from the Urals into most collections. It is late to quarrel with the makers of new names, but didymolite, with no didymium, platynolite, suggesting platinum when pronounced, and Prof. Ford's own pyroxmangite for "manganopyroxene," strike us as unfortunate. The author of this appendix, however, will at once be gratefully absolved.

G. A. J. C.

The Structure of the Fowl. By Dr. O. C. Bradley. Pp. xi+153. (London: A. and C. Black, Ltd., 1915.) Price 3*s*. 6*d*. net.

The author of this little volume has successfully accomplished a somewhat difficult task in his effort to produce a concise and not too elaborate account of the structure of the fowl. The first chapter deals with the zoological position of birds, and includes a very interesting account of the probable ancestry of the domestic fowl. This is followed by chapters on the skeleton and muscular system, both of which are of necessity dealt with in a very elementary fashion. More detail is entered into when the author deals in successive chapters with the digestive system, the respiratory organs, the urinary organs, the reproductive organs, and the circulatory system. The descriptions of the macroscopic characters of these apparatuses are so clear and lucid that they can be well and easily followed by readers who have received little or no previous anatomical training, while the microscopic structure is dealt with in such a masterly way as to render the book of the greatest assistance to the student of comparative histology and pathology. The illustrations in these sections are excellent, and have very considerably simplified the author's task. The nervous system, the eye and its appendages, and the ear are briefly considered, and a chapter is also devoted to the skin and its appendages.

Probably the best chapter is that on the development of the chick, which is dealt with in rather more detail, the various stages being well illustrated.

While this little book would appear to contain little or nothing that is new, it is the only work with which we are acquainted that contains such an excellent general description of the structure of the fowl. The illustrations must be regarded as a special feature. There are seventy-three of them, and many are full-page plates.

There is a very complete index. G. H. W.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Structure of the Line of Wave-Length 4686 A.U.

Previous experiments by one of us (Nature, vol. xcii., p. 5; *Phil. Mag.*, vol. xxix., pp. 284–297, 1915) have shown that the 4686 line could be obtained by passing a condenser discharge through pure helium, and it was concluded that the results supported a theory put forward by Dr. Bohr (*Phil Mag.*, vol. xxvi., p. 1, 1913). This theory, which was deduced by applying the quantum hypothesis to Sir Ernest Rutherford's atom-model, ascribed the line to helium. On the other hand, Rydberg, assuming the Pickering lines to constitute the sharp series of hydrogen from analogy with the spectra of the alkali metals, obtained by calculation the value 4687·88 for the wave-length of the first line of the principal series of hydrogen.

The present experiments on the structure of the line were commenced with the purpose of testing still further its chemical origin, and of obtaining results which would throw further light on the mechanism of emission of spectrum lines. The importance of accurate knowledge of the structure of hydrogen and helium lines from the latter point of view has already been shown by Bohr (*Phil. Mag.*, vol. xxix., p. 332, 1915). It is well known that the hydrogen lines of the Balmer series are not single lines, but close doublets, and it is therefore to be expected from both Rydberg's and Bohr's theories, that the 4686 line should also have a complex structure. According to Rydberg's theory, the line should be a doublet having the same frequency difference as the members of the Balmer series. The recent measurements of Buisson and Fabry gave 0·132 A U. as the separation of the two components of Hα, and it follows by calculation that the two components of the 4686 line should be separated by 0·0674 A.U. From Bohr's theory, the details of the structure of the line could not be anticipated, but from the supposed analogy between the mechanism of emission of the 4686 line and the lines of the Balmer series, it was hoped that a knowledge of the structure of the line would serve as a guide in testing different hypotheses for explaining the doubling of the hydrogen lines.

The origin of the "4686" line has recently been studied by Merton (Nature, vol. xcv., p. 64; Proc. Roy. Soc., vol. xci., p. 382, 1915), who used a method based on Lord Rayleigh's theory of the width of spectrum lines. He concluded that either the breadth of the line is controlled by circumstances at present unknown, or that the line originates from systems of sub-atomic mass. Later experiments by the same author (Proc. Roy. Soc., vol. xci., p. 421, 1915, February, 1916) show that the widths of some spectrum lines are not wholly due to the motion of the molecules.

In our first set of experiments the line was excited by passing a condenser discharge through a helium

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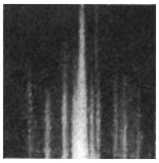
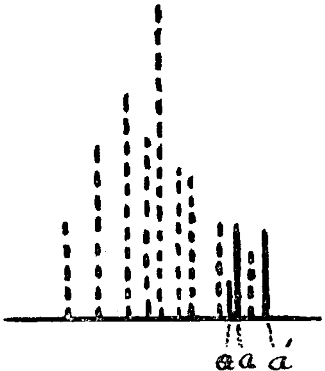
tube with an adjustable spark gap in series with it. The structure of the line was studied by means of an echelon spectroscope, consisting of thirty-three glass plates, each plate being 9·48 mm. thick. The resolving power of the instrument at 4686 was 441,421, and the distance between successive orders of the line was 0·350 A.U. The line when excited by a condenser discharge was found to be very broad and diffuse, and two successive orders were only just separated on the best photographs. In some experiments the spectrum tube was immersed in liquid air, but no measurable improvement in the sharpness of the line was obtained. This result may also be expected on Bohr's theory, as the atom is charged when emitting the lines. It was therefore decided to excite the line by means of a direct current, keeping the drop of potential between the anode and kathode as low as possible. The direct-current machine, which was connected through a liquid resistance to the electrodes, could give a voltage of 2000 and an output of one kilowatt. As fairly large currents were passed through the gas the cylindrical spectrum tube was made large, and was also provided with two heavy aluminium electrodes, one of which was concave and the other a hollow cylinder. The tube was used in the end-on position.

It was found that when the cylindrical electrode was made the kathode the light was almost completely confined to the space inside the cylinder, and that it was very intense. Experiments were usually conducted at a pressure of 1 mm., and the voltage between the anode and kathode varied in different experiments between 280 and 400. Under these conditions, although the ordinary helium lines were strong, the 4686 line was comparatively faint, and exposures of about two hours were necessary for obtaining a satisfactory photograph.

The line was found to be surprisingly sharp; in fact, it was comparable in sharpness with the lines of the ordinary helium spectrum, and much sharper than the $H\beta$ line of hydrogen, which was photographed at the same time. In addition, all the photographs showed that the line was a close doublet, the components having almost equal intensity. The best photographs were measured up, and the distance apart of the two components was found to be 0·094 A.U. It is interesting to note that the separation to be expected on Rydberg's theory is 0·067 A.U.

The structure of the line is shown in the accompanying photograph, which is explained by the diagram. The dotted lines represent the different orders of the 4713 helium line and its faint component, and the full lines the 4686 line. The doublet is represented by aa_1, and a^1 is a higher order of a.





These experiments were still in progress when there appeared a very interesting theoretical paper by Sommerfeld (*Bay. Akad. d. Wiss.*, Munich, 1916) on the structure of spectrum lines, which was based on a remarkable generalisation of Bohr's theory. In this paper he quotes certain unpublished results of Paschen on the structure of several lines of the series

$$n=k'\left\{\frac{1}{(1\frac{1}{2})^2}-\frac{1}{\left(\frac{n}{2}\right)^2}\right\}$$

the first member of which is the 4686 line, and also of several lines of the series

$$n=k'\left\{\frac{1}{(2)^2}-\frac{1}{\left(\frac{n}{2}\right)^2}\right\}$$

which includes the Pickering lines, and also another series of lines near the hydrogen lines, one member of which, at 6560·4, was first observed by one of us in a helium tube.

In complete agreement with Sommerfeld's theory Paschen found that the 4686 line consisted of three components, each of which was accompanied by fainter satellites, and the two stronger components were separated by a distance one-fourth of that between the outer components. The values of the separations in Angstrom units as obtained by Paschen are not given in Sommerfeld's paper, but it is stated that the ratios of the separations of the components of the 4686 line to the separations of the components of $H\alpha$ agree with the values predicted by the theory. Our result for the distance between the components of the doublet also agrees approximately with the value predicted by Sommerfeld for the separation of the two strongest components. Since the appearance of the paper we have re-examined all our photographs to see if they show the presence of a third faint component which we had missed. On our best photograph we found near one of the higher orders of the doublet, but not completely separated from it, a faint line. If this line is a lower order of the third component its separation measured from the doublet is about 0·40 A.U., and it is situated on the higher wave-length side, as is to be expected according to Sommerfeld's theory.

E. J. EVANS.
C. CROXSON.

Manchester University, March 4.

Ground Rainbows.

MR. A. E. HEATH asks (NATURE, March 2, p. 5) how gossamer which "seems to be a kind of spider web, comes to be spread over so large an area." Mr. Heath need have gone no further than Selborne to find the correct explanation, given by Gilbert White 140 years ago:—"Nobody in these days doubts that they (the cobweb-like appearances) are the real production of small spiders which swarm in the fields in fine weather in autumn, and have a power of shooting out webs from their tails so as to render themselves buoyant." Possibly the first part of the sentence was not true when Gilbert White wrote it, seeing that it is not always the case to-day. The thick clouds of gossamer noticed by Mr. N. T. Porter when out shooting in the early morning were noticed also by Gilbert White in September, 1741, when "intent on field diversions I rose before daybreak." If a more recent account of gossamer is preferred it may be found in Fabre's "Life of a Spider."

CHARLES J. P. CAVE.

Meteorological Office, South Farnborough,
March 7.

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